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(54) Title: A METHOD FOR INCORPORATING PSYCHOLOGICAL EFFECTS INTO DEMAND MODELS

(57) Abstract

A method for incorporating psychological effects into a demand model for pricing. First the original demand model is modified to include a mechanism to convert actual prices into perceived prices, thus causing the demand model to predict higher demand for certain prices. The user specifies the function that converts from real prices to perceived prices. This modified demand function is then fitted to a sales history to yield the parameters appropriate to its particular form. Also, the demand model can be modified to account for promotional effects. The user defines a visibility model, which gives the relative increase in demand for an item caused by a promotion, and the cost of the promotion. The demand model is modified to include the effect of increased demand based on the visibility, and a profit model is modified to account for the added cost due to the added visibility. The profit model is then optimized with respect to both prices and promotions.

A METHOD FOR INCORPORATING PSYCHOLOGICAL
EFFECTS INTO DEMAND MODELS

BACKGROUND OF THE INVENTION

1. Field of the Invention

5   The present invention relates to demand models, and more particularly, to software that incorporates psychological factors into consumer demand models.

2. Description of Related Art

10   Present pricing methods, while taking into account a tremendous amount of information, ultimately depend upon a pricing analyst's expert intuition for setting prices. This reliance on a human entails a slow and qualitative pricing process. Even if this intuition could be captured by an expert system, it would still lack the quantitative description necessary to

15 actually optimize prices. Businesses are being faced with an increasingly competitive and sophisticated environment, leading to lower margins and a stronger focus on pricing. The need for more rigorous, model-based approaches to pricing is becoming more urgent.

     There are, however, problems with the use of model-based decision-

20 making tools. As the decision-making process is automated, the operational decisions that are recommended by the model may deviate from the decisions of experienced pricing managers. One reason is that pricing managers usually consider the psychological effects that their decisions will have on consumers. For example, pricing managers know that a buyer's perception of a price is

25 very important, and they intuitively incorporate this knowledge into their

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pricing. For example, there will be far more items in a retail store priced at $1.99, than priced at $2.00. This phenomenon is often referred to as a price threshold.

Another factor that impacts heavily on a buyer's psychological view of the marketplace is promotional activity. Vast amounts of money are spent on a whole range of promotions, from coupons to advertisements to commercials. The effect of promotions on the sales of an item has been studied extensively, but these promotional decisions are rarely addressed within the broader context of the whole value chain.

SUMMARY OF THE INVENTION

The present invention provides a method for incorporating psychological effects such as price thresholds and promotional activity into a demand model. In a preferred embodiment of the present invention, software is used to implement a demand model that is modified to include the price threshold. One advantage of the present invention is that any demand model may be used, as the invention modifies only the price variable in the demand model, leaving the other parts untouched. The modified demand model can be used anywhere that an unmodified demand model would be used, for example, in a forecasting system. A particularly important use is as part of a price optimization routine, where the model is tuned to a sales history and then used to generate predicted optimal prices.

The demand model can be further modified to account for promotional effects. This is accomplished by making use of a novel concept called "visibility," which is defined as the amount by which the demand for an item is increased when a given promotion is run. Associated with each promotion is a visibility, which in general can be determined from empirical study, and a promotional cost, i.e., the amount of money spent on the promotion. By

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including the visibility in the demand model and also taking into account the promotional cost, the pricing and promotional decisions can be optimized together such that an optimized maximum profit can be obtained. For example, the method of the present invention could be utilized to determine both an

5   optimum price and an optimum promotional activity, such as a newspaper ad, for a given item so that the highest profits could be obtained. In addition to sales of items, the above techniques can be applied to the sale of services.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a high-level block diagram of a general-purpose computer system

10   used in accordance with the present invention;

Fig. 2 is a picture of an example of aninput menu displayed on the display device;

Fig. 3 is a flowchart describing the overall operation of a preferred embodiment of the system;

15   Fig. 4A is a flowchart of a preferred embodiment of the Model Selection routine;

Fig. 4B is a picture of an example of possible user input displayed on the display device for the Model Selection routine;

Fig. 5 is a flowchart of a first preferred embodiment of a routine for

20   incorporating perceived prices into a demand model;

Fig. 6 is a table representing a data structure in memory in the first preferred embodiment of the routine for incorporating perceived prices into a demand model;

Fig. 7 is an example of a price decomposition used in a first preferred

25   embodiment of the routine for incorporating perceived prices into a demand model;

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Fig. 8 is a flowchart of a second preferred embodiment of a routine for incorporating perceived prices into a demand model;

Fig. 9 is a table representing a data structure stored in memory of a second preferred embodiment of the routine for incorporating perceived prices into a

5   deₘₐnd model;

Fig. 10 is an example of a perceived price determined from the data from Fig. 9;

Fig. 11 is an example of a visibility table; and

Fig. 12 is a table representing an example of a data structure stored in

10   memory holding the results of the Optimizing Process.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The following description is present to enable one of ordinary skill in the art to make and use the invention and is provided in the context of a patent

15   application and its requirements.   Various modifications to the illustrated embodiments will be readily apparent to those skilled in the art and the generic principles herein may be applied to other embodiments.   Thus, the present invention is not intended to be limited to the embodiments shown but is to be accorded the widest scope consistent with the principles and features described

20   herein.

The present invention provides a computer-implemented method for incorporating psychological effects such as price thresholds and promotional activity into a demand model.   In a first preferred embodiment, a retailer utilizes collected point-of-sale data (hereinafter "sales data") to predict the

25   consumer demand of its retail products.   The retailer selects an appropriate consumer demand model which is modified to incorporate the psychological effects that various pricing and promotional decisions have on consumers.   The

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modified demand model is then tuned to the sales data, and can be used anywhere an unmodified demand model would be used, for example, in a price optimization routine.

5   The operation of a first preferred embodiment of the present invention will be described with respect to a sample application in retailing; however, it is to be understood that the present invention can be applied to any situation where the modeling of consumer demand is utilized. As shown in Figure 1, in a first preferred embodiment of the present invention, a system includes: an input device 101 such as a keyboard, through which a user enters commands, inputs

10   functions, etc.; a display device 102 for displaying tables, etc.; a storage device 103 such as hard disk drive for storing results; a memory 104 for storing program instruction, tables and results; a processor 105 for performing various kinds of processing and controlling the overall operation of the system.

The memory 104 includes: a general control portion 111 for storing

15   program instructions for controlling the overall operation of the system; a Tuning portion 112 for performing the tuning of a modified demand model; an Optimizing portion 113 for generating optimized prices; an internal storage portion 114 for storing data necessary for the various routines.

It will be understood that the described embodiments of the present

20   invention are embodied as computer instructions stored in memory 104 and executed by processor 105. These instructions can also be stored on a computer readable medium, such as a floppy disk, CD ROM, etc., and can also be transmitted in a network such as the internet, an intranet, etc., via a carrier wave embodying the instructions.

25   Operation of the System

The operation of a first preferred embodiment of the present invention will be described in brief with reference to Figures 2 and 3 before being

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described in detail with reference to Figures 4 to 6.

In the first preferred embodiment, a retailer seeking to utilize a demand model to analyze pricing decisions is shown a menu on the display device 102 as illustrated in Figure 2. At this time the user enters one of the following

5   selections through the input device 101: '1' to select models, '2' to perform the tuning process, '3' to perform the optimization of prices and promotional decisions, '4' to output results to the storage device 103, and 'Q' to terminate use of the system. Other appropriate methods and formats of input can, of course, be used.

10   The processor 105 receives the entered information, and the situation of the system is passed to one of the appropriate steps described below, according to the inputted value. This is represented schematically in Figure 3.

(Step 1001): Model Selection

15   At this step, the user first selects a consumer demand model to be tuned to the sales data. Next, the user selects a perceived pricing model (i.e., a model that predicts the psychological effects that given prices have on consumers), and then a visibility model (i.e., a model that predicts the psychological effects that given promotions will have on consumers), these models will be described

20   in detail below. The details of a preferred embodiment of the Model Selection routine will be discussed below in conjunction with Figures 4A and 4B.

(Step 1002): Tuning Process

At this step, the selected demand model is modified with the selected

25   perceived pricing model and the selected visibility model. This modified demand model is then tuned to the sales data. It will be appreciated by those having ordinary skill in the art that a retailer can utilize this tuned demand model to make pricing and promotion decisions that are consistent with the

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psychological effects that those decisions will have on consumers. The details
of a preferred embodiment of this routine are discussed below.

(Step 1003): Optimization Process

5   At this step, the parameters of the modified demand model are used to
generate a set of optimized prices and promotional decisions.

(Step 1004): Output Results   .

The optimized prices and promotional decisions are outputted to the
10   external storage device 103, from which they may be accessed for
implementation by an appropriate user.

Model Selection

A preferred embodiment of this routine will be described with reference
15   to Figures 4A and 4B. The user is presented with a menu on the display 102,
such as illustrated in Figure 4B, to prompt the user through the Model
Selection routine as illustrated in Figure 4A. It should be appreciated that
other appropriate methods and formats of input can, of course, be used, and
that the simplified menu of Figure 4B is presented for illustrative purposes
20   only.

(Step 1101)

The user enters a demand model to predict sales. Consumer demand
models are known in the art, and in a preferred embodiment, the user will be
25   provided with a database of predefined demand models from which to choose.
It is also contemplated, as illustrated in Figure 4B, that the user will be given
the option of defining a new demand model, allowing the user to tailor a model

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to meet the user's specific needs. In general a demand model $q = q(p; X)$ gives the predicted sales q of an item based upon its price p and possibly other factors X. The demand model illustrated in Figure 4B is a one-dimensional model that determines the demand for an item i based solely upon operational

5   variables affecting item i, such as price p; however, it should be appreciated that the present invention can be utilized with any demand model, for example, one that incorporates the price of other items, the sales history of selected items, etc.

10   (Step 1102)

Next, the user selects a perceived pricing model, which is utilized to predict the perceived prices—i.e., the prices that account for the price threshold phenomenon. In a preferred embodiment, the user will be provided with a database of predefined perceived pricing models from which to choose,

15   and will also have the option of defining a new perceived pricing model. Further, the perceived pricing model of a preferred embodiment will be represented as a function having the form $p(p; B_{1...N})$. This function depends upon the original price p as well as a number of parameters $B_{1...N}$; two preferred embodiments of the perceived pricing model will be discussed below.

20

(Step 1103)

Next, the user selects a visibility model, which measures the change in demand of an item due to various levels of promotion of that item. In a preferred embodiment, the user will be provided with a database of predefined

25   visibility models which are constructed from the sales history, and will also have the option of defining a new visibility model. Further, the visibility model of a preferred embodiment will be represented as a visibility cost function having the form $c_v(V)$, which gives the cost that a promotion incurs, as a

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function of the visibility, denoted as V. This quantity is defined as the increase in demand that a promotion incurs, relative to the demand without promotion. A preferred construction of the visibility cost function is described below.

5   Tuning Process

A preferred embodiment of the Tuning Process will now be described. The original demand model having the general form q = q(p; X) as given above, is modified to incorporate the psychological effects associated with perceived prices and visibility. The modified demand model will have the form

$$q = Vq\left(\rho\left(p; B_{1...N}\right); X\right)$$

10

This modified demand model is then fitted to a sales history, as would be done with a ordinary demand model. However, in addition to fitting the parameters X from the original demand model, the parameters $B_{1...N}$ from perceived pricing model are also fitted.

15   As shown above, the visibility is also used to modify the sales history according to the promotional activity that was occurring at the time of the sale. However, often times information on the promotional activity associated with an item is not available, at least not in a form suitable for analysis. In this case, the tuning may be performed using the perceived pricing process, using the

20   following modified demand model:

$$q = q\left(\rho\left(p; B_{1...N}\right); X\right)$$

This tuning may be performed using any standard fitting technique, such as the chi-squared method; such fitting techniques are well known in the art.

10

Optimizing Process

A user can utilize the fitted, modified demand model from the Tuning Process to determine the price for each item that will maximize profits. As known in the art, profits can be maximized by optimizing a profit function

5   having the general form:

$$\Pi = \sum_i q_i(p_i; X_i)[p_i - c_i]$$

However, in order to incorporate the perceived prices and visibility, the above objective function is modified with the modified demand function to yield a modified objective function, which has the following general form:

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$$\Pi = \sum_i V_i q_i(\rho(p_i); X_i)[p_i - c_i] - c_{v_i}$$

The independent variables that the profit Π depends upon are the price p_i for each item and the visibility V_i for each item. Thus, in addition to optimizing the price p, the optimization routine can also optimize the promotional activity on the item, which is now encapsulated in the variable V. Since the cost c_{v_i} of the

15   promotions is now incorporated into the profit objective function, both pricing *and* promotion decisions can be optimized in a comprehensive manner.

The optimization of prices and promotions that yield the maximum profits Π can be performed using any mathematical optimization routine. A preferred technique, however, is the method of simulated annealing which is

20   presented in W. Press *et. al.*, *Numerical Recipes: The Art of Scientific Computing*, Cambridge University Press, New York (1992), which is hereby incorporated by reference. Because the modified demand model $q(\rho(p))$ may potentially be a set of coupled, multidimensional, nonlinear and discontinuous equations, simulated annealing is particularly suited for this type of

25   optimization.

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Once the optimal price and visibility for each item has been determined, the prices may be assigned to the items and the promotional activity which corresponds to the value of V may be implemented for each item. An example of possible output from the optimization process is provided in Figure 12. As

5   illustrated, the output comprises a list of items, ai. optimal price for each item, and an optimal level of visibility for each item. Thus, a pricing manager seeking to maximize profits is provided with list of prices and corresponding promotional activity

Perceived Pricing

10   The determination of the perceived prices involves taking the original price p and converting it to aperceived price ρ that the shopper unconsciously believes the item has. Two preferred embodiments for making this conversion are presented below. Each embodiment presents a way to construct a routine that takes as input the price p and a set of parameters $B_{1...N}$, and outputs a

15   psychological price ρ.

First Preferred Embodiment of the Perceived Pricing Model

A first preferred embodiment of the perceived pricing model will be described below in conjunction with Figures 5-7.

20   (Step 1201)

First, the user chooses a set of base units D_u, which represent monetary units to which consumers are likely to be attuned in a given market. The units chosen will vary according to the local currency or currencies, common counting units in the market of interest, etc. An example of one possible set of

25   base units D_u that may be input by the user is denoted by reference numeral 150 in Figure 6. It is further contemplated that an optimum set of base units D_u can be determined by analyzing the chi-squared value that is yielded when the

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weighting function (discussed below) is fit to the sales data using the various possible combinations of base units for the local currency.

(Step 1202)

5   Next, as illustrated in Figure 6, the price p is decomposed into the set of base units D_u 150. The price p is decomposed by choosing a set of N_u such that the following equation is satisfied:

$$P = \sum_u N_u D_u$$

As shown in Figure 6, the price $1.99 is thus decomposed into 9 units of $0.01,

10   4 units of $0.10, 1 unit of $0.50 and 1 unit of $1,00.

(Step 1203)

Next, a weighting function having the general form $\Gamma_u = \Gamma_u(D_u; B_{1...N})$ is selected. Generally, the weighting function includes a set of parameters that is

15   used to tune the perceived pricing model to the sales data. The weighting function will vary according to factors such as the desired ending number frequency. One possible form is

$$\Gamma_u = 1 + \eta \ln\left(\frac{D_u}{D_{MAX}}\right)$$

In the form presented above, D_{max} is the largest base unit in the list D_u that is

20   contained in the price p, and η is the only tunable parameter.

(Step 1204)

The perceived price is next composed according to the following equation

$$\rho = \sum_u N_u D_u \Gamma_u$$

5   The perceived price of $2.20 is determined in Figure 7, which makes use of the price decomposition from Figure 6. The parameter η is obtained by fitting the modified demand function $q = V \cdot q(\rho(p; \eta); X)$ to a particular sales history. This fitting would determine η, as well as all the other fitted parameters of the demand function, by determining the value of the parameters that minimizes the

10   chi-squared fitting function.

Second Preferred Embodiment of the Perceived Pricing Model

A second preferred embodiment of the perceived pricing model will be described below in conjunction with Figures 8-10. This second preferred embodiment is based on the recognized fact that consumers may perceive a

15   price p as being perceptually similar to other prices.

(Step 1301)

First, the user selects a set of base prices p_u, based upon the price p. In general, the set of base prices p_u is constructed by listing a set of perceptually

20   similar prices for each price p. For example, a price of $1.99 might be perceived by consumers as $1, $1.9, or $1.99. The perceptually similar prices will necessarily be different for every price point; however, the example in Figure 9 shows that the ignoring of successive digits is a process that is easily generalized into a set of base prices p_u. Other sets of base prices can, of

25   course, be used. For example, a price of $2.69 could be perceived as $2, $2.6, $2.69, or $2.96.

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(Step 1302)

At this step, the user selects an appropriate set of weighting functions w_u that estimate the likelihood that a consumer would perceive the price p as

5   p_u. The choice of weighting functions will depend upon the choice of perceptually similar prices from the previous step. In the example from above, where the perceptually similar prices were chosen by ignoring successive digits, the weighting functions can be constructed by estimating the percentage of shoppers that would successively ignore one or two digits, and applying this

10 percentage as the weighting function w_u; this is demonstrated in Figure 9. It should be appreciated that the weighting functions could take various other forms and be constructed in many different manners.

(Step 1303)

15 The perceived price ρ is next composed according to the following form

$$\rho = \sum_u W_u P_u$$

Thus, the perceived price represents an effective price that averages all the different perceptions that shoppers might have of the original price. A sample

20 calculation is shown in Figure 10, making use of the data in Figure 9.

In both of the perceived pricing embodiments described above, it should be apparent that the perceived price is usually quite different from the actual price. For example, as shown in Figure 9, a price of $1.99 is perceived by the consumer as being a price of $1.89. This is precisely the effect that the

25 perceived pricing function is attempting to capture. When the perceived pricing method is used in a demand model, the true demand based on the

15

perceived price of an item is used to optimize the true price. In calculating all other quantities, such as profits, sales, etc., the true price of the items is used.

Visibility Model

5   The choice of the visibility model is determined by the types of promotions that are run, and the general effects of those promotions on sales. In general, the visibility model describes how the demand for an item changes according to a promotion run on the item. For instance, if there is a sign in a store that displays a particular item's price, it may be expected that the demand for that item will increase. However, if there is a newspaper advertisement, the

10   increase in demand will be different, and different yet again for a radio or television commercial. In addition, each of these promotional methods will have a particular cost associated with them.

In a preferred embodiment, the visibility model will be in the form of a table providing the relative increase in demand for an item at a given price vis-

15   à-vis no promotion, along with the cost of the promotion. This table would thus provide a definition of the visibility cost function $c_v(V)$. An example of such a table is shown in Figure 12, and can be constructed by analyzing in the sales history, the demand for individual items for given promotions. In many instances, a single promotion, such as a newspaper ad, will promote multiple

20   items. In this case, the cost for the promotion should be divided up amongst all the items being promoted.

Once the visibility model has constructed, it can be incorporated into the demand model, which will then give the change in demand for an item based upon both its price and any promotions that modify this visibility.

25   Having thus described a preferred embodiment of the Method for Incorporating Psychological Effects into Demand Models, it should be apparent to those skilled in the art that certain advantages of the within method have

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been achieved. It should also be appreciated that numerous modifications, adaptations, and alternative embodiments thereof may be made within the scope and spirit of the present invention.

For example, the illustrated embodiments incorporate perceived pricing

5   and visibility into a demand model; however, it should be appreciated that the method described herein may be extended to other psychological effects that may affect consumer demand.

The above description is presently the best contemplated mode of carrying out the invention. This illustration is made for the purposes of

10   illustrating the general principles of the invention, and is not to be taken in a limiting sense. The scope of the invention is best determined by reference to the following claims.

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What is Claimed is:

1. A computer-implemented method for incorporating at least one psychological effect into a demand model comprising the steps of:

        selecting a demand model, said demand model including a plurality of

5   parameters, each of which represents an operational decision, said plurality of parameters including a price parameter;

        selecting at least one psychological effect that affects said operational decisions of said demand model;

        constructing a psychological effect model to predict said at least one

10   psychological effect of said operational decisions on potential consumers; and

        modifying said demand model with said psychological effect model, thereby creating a modified demand model that can be utilized to optimize operational decisions.

15   2. The computer-implemented method of Claim 1, further comprising the steps of:

        providing a data storage having past sales data; and

        tuning said modified demand model to said sales data to determine optimized values for said plurality of parameters, thereby

20   obtaining an optimal set of operational decisions that takes into account said at least one psychological effect.

3. The computer-implemented method of Claim 2, wherein said at least one psychological effect includes a perceived price which represents the consumers' perception of an actual price of an item, wherein an actual

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demand on an item having said actual price is affected by said perceived price.

4. The computer-implemented method of Claim 2, wherein said at least one psychological effect includes a visibility which represents the affect that promotional activities for an item have on said item's demand.

5. The computer-implemented method of Claim 3, wherein said at least one psychological effect further includes a visibility which represents the affect that promotional activities for an item have on said item's demand.

6. The computer-implemented method of Claim 3, wherein said step of constructing a psychological effect model further includes the steps of:
    choosing a set of base units for a market;
    decomposing said actual price into said base units;
    selecting a weighting function including at least one tunable parameter; and
    applying said weighting function to said decomposed actual price, thereby forming a perceived price model,
    wherein said psychological effect model includes said perceived price model.

7. The computer-implemented method of Claim 3, wherein said step of constructing a psychological effect model further includes the steps of:
    choosing a set of base prices based upon said actual price, said set of base prices including prices perceptually similar to said actual price;

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selecting a weighting function to be applied to each of said prices in said set of base prices; and

applying said weighting function to said set of base prices, thereby forming a perceived price model,

5   wherein said psychological effect model includes said perceived price model.

8. The computer-implemented method of Claim 3, wherein said step of constructing a psychological effect model further includes the steps of:

10   choosing a set of base prices based upon said actual price, said set of base prices including prices perceptually similar to said actual price;

selecting a weighting function to be applied to each of said prices in said set of base prices;

15   applying said weighting function to said set of base prices, thereby forming a first perceived price model;

choosing a set of base units for a market;

decomposing said actual price into said base units;

selecting a weighting function including at least one tunable parameter;

20   and

applying said weighting function to said decomposed actual price, thereby forming a second perceived price model; and

combining said first perceived price model and said perceive price model, thereby forming a final perceived price model;

25   wherein said psychological effect model includes said final perceived price model.

9. The computer-implemented method of Claim 3, wherein said step of constructing a psychological effect model further includes the step of:

> constructing a visibility model from said sales data, said visibility model including a type of said promotional activity and its associated effect on said item's demand;

> wherein said psychological effect model includes said visibility model.

10. The computer-implemented method of Claim 6, wherein said step of modifying said demand model includes the step of

> substituting said price parameter in said demand model with said perceived price model.

11. The computer-implemented method of Claim 7, wherein said step of modifying said demand model includes the step of:

> substituting said price parameter in said demand model with said perceived price model.

12. The computer-implemented method of Claim 8, wherein said step of modifying said demand model includes the step of:

> multiplying said demand model by said visibility model.

13. A computer-readable storage medium, for use on a computer having a storage device for storing sales data, said computer-readable storage medium for storing program code for causing a computer to perform the steps of:

> providing a data storage having past sales data;

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selecting a demand model, said demand model including a plurality of
parameters, each of which represents an operational decision,
said plurality of parameters including a price parameter;

selecting at least one psychological effect that affects said operational

5   decisions of said demand model;

constructing a psychological effect model to predict said at least one
psychological effect of said operational decisions on potential
consumers;

modifying said demand model with said psychological effect model; and

10   tuning said modified demand model to said sales data to determine
optimized values for said plurality of parameters, thereby
obtaining an optimal set of operational decisions that takes into
account said at least one psychological effect.

14. The computer-readable storage medium of Claim 12, wherein said at least

15   one psychological effect includes a perceived price which represents the
consumers' perception of an actual price of an item, wherein an actual
demand on an item having said actual price is affected by said perceived
price.

15. The computer-readable storage medium of Claim 12 wherein said at least

20   one psychological effect includes a visibility which represents the affect that
promotional activities for an item have on said item's demand.

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16. The computer-readable storage medium of Claim 13, wherein said at least
one psychological effect further includes a visibility which represents the
affect that promotional activities for an item have on said item's demand.

17. The computer-readable storage medium of Claim 14, wherein said step of
5   constructing a psychological effect model further includes the steps of:
        choosing a set of base units for a local currency;
        decomposing said actual price into said base units;
        selecting a weighting function including at least one tunable parameter;
            and
10   applying said weighting function to said decomposed actual price,
            thereby forming a perceived price model,
        wherein said psychological effect model includes said perceived price
            model.

18. The computer-readable storage medium of Claim 14, wherein said step of
15   constructing a psychological effect model further includes the steps of:
        choosing a set of base prices based upon said actual price, said set of
            base prices including prices perceptually similar to said actual
            price;
        selecting a weighting function to be applied to each of said prices in
20   said set of base prices;
        applying said weighting function to said set of base prices, thereby
            forming a perceived price model,
        wherein said psychological effect model includes said perceived price
            model.

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19. The computer-readable storage medium of Claim 14, wherein said step of

constructing a psychological effect model further includes the step of:

    constructing a visibility model from said sales data, said visibility model

        including a type of said promotiona' activity and its associated

5   effect on said item's demand;

    wherein said psychological effect model includes said visibility model.

20. The computer-readable storage medium of Claim 16, wherein said step of

modifying said demand model includes the step of:

    substituting said price parameter in said demand model with said

10   perceived price model.

21. A system for incorporating psychological effects into a demand model, said

system for use with a storage device having sales data stored thereon, said

system comprising:

    means for selecting a demand model, said demand model including a

15   plurality of parameters, each of which represents an operational

        decision, said plurality of parameters including a price

        parameter;

    means for selecting at least one psychological effect that affects said

        operational decisions of said demand model;

20   means for constructing a psychological effect model to predict said at

        least one psychological effect of said operational decisions on

        potential consumers;

    means for modifying said demand model with said psychological effect

        model; and

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means for tuning said modified demand model to said sales data to

determine optimized values for said plurality of parameters,

thereby obtaining an optimal set of operational decisions that

takes into account said at least one psychological effect.

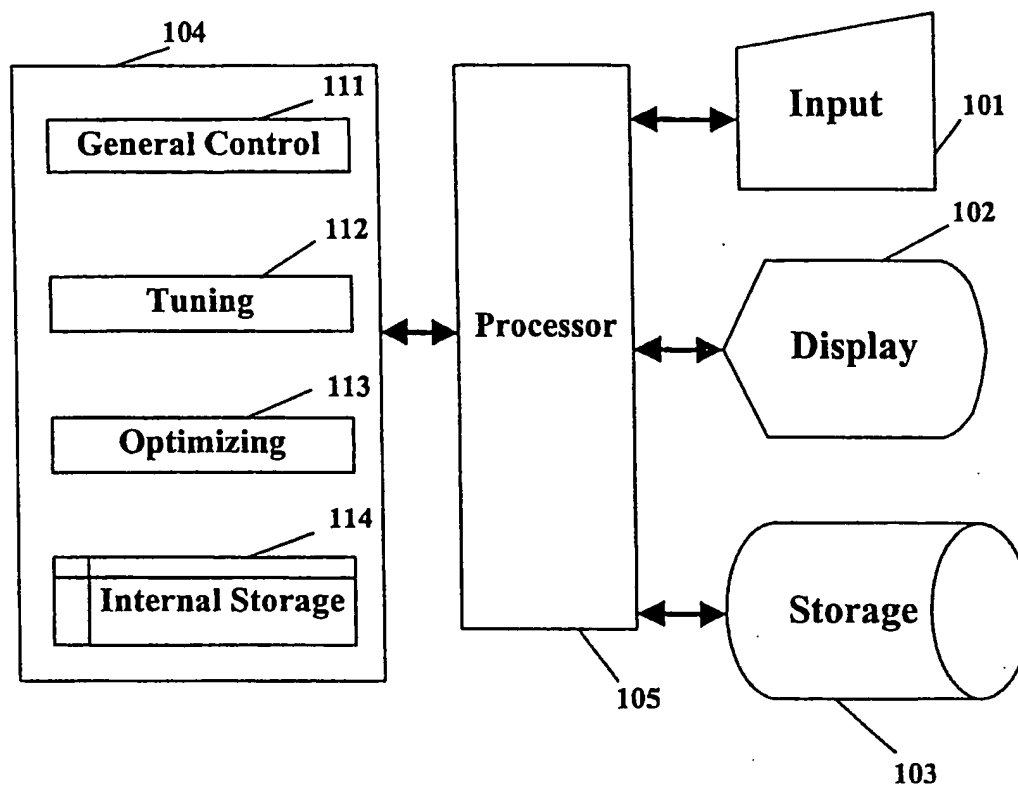**Figure 1**

Enter Selection

> _

        1: Select Models

        2: Perform Tuning Process

        3: Optimize Pricing and Promotions

        4: Output Results

        Q: Quit
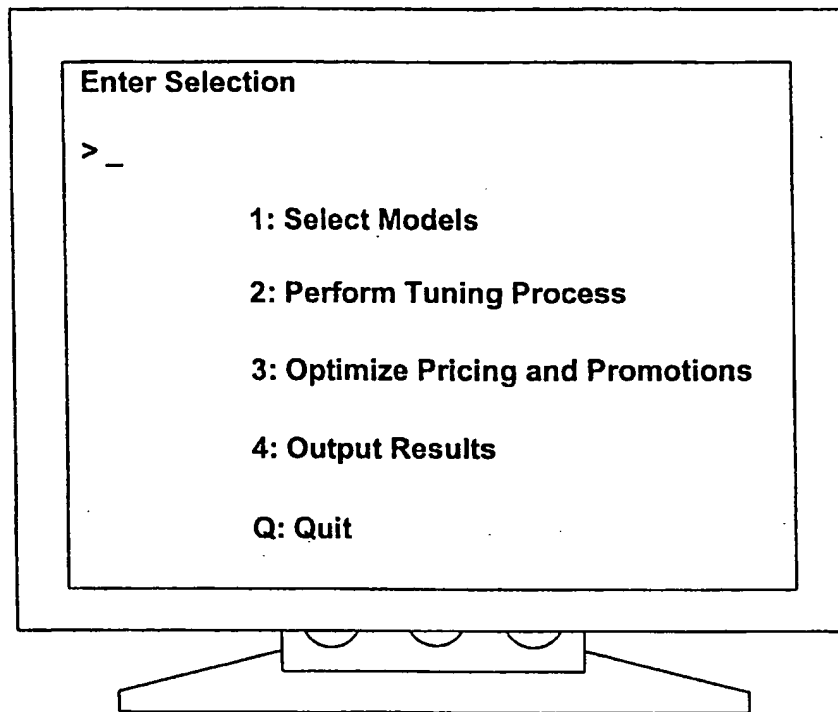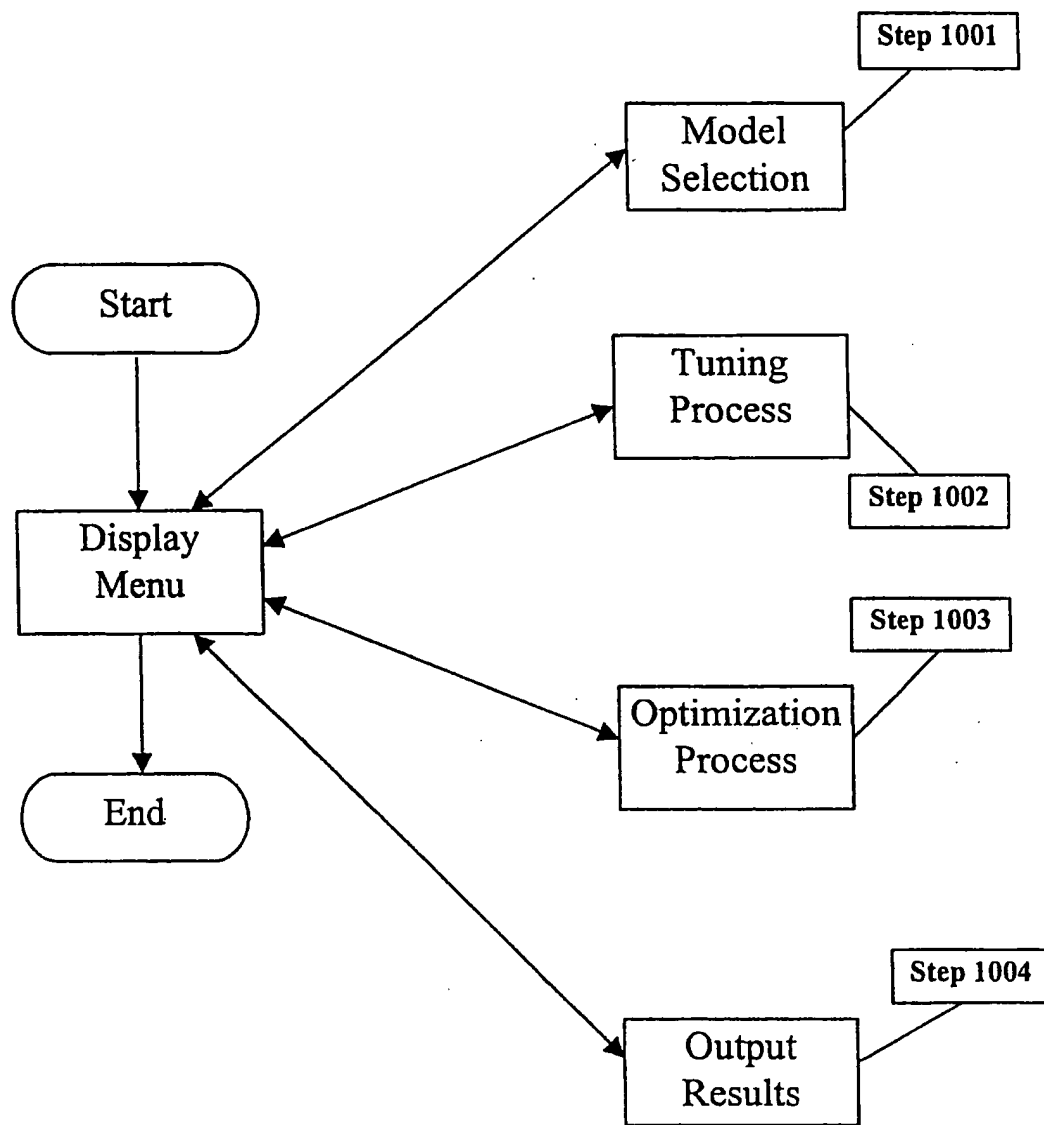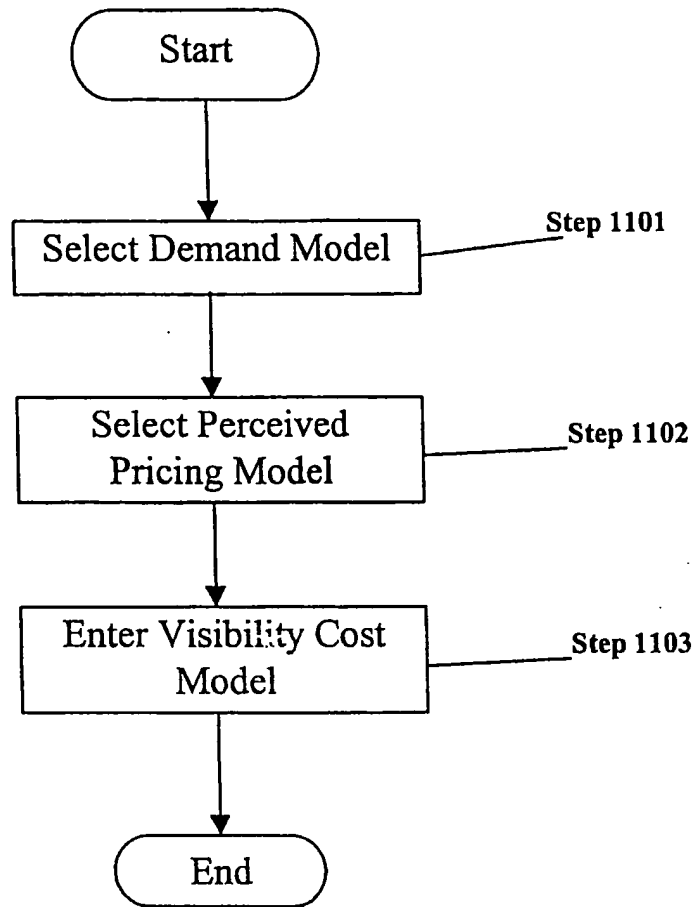
Figure 2

Figure 3

Figure 4A

Select Models

>2

Select Demand Model

      1. Select Predefined Demand Model

      2. Define New Demand Model

$$>q_i = q_i^\circ \exp(-g_i\,(p_i/p_i^\circ))$$

Select Perceived Pricing Model

      3. Select Predefined Perceived Pricing Model

      4. Define New Perceived Pricing Model

Select Visibility Model

      5. Select Predefined Visibility Cost Model

      6. Define New Visibility Cost Model

      Q. Return to Main Menu

Figure 4B

Figure 5

120
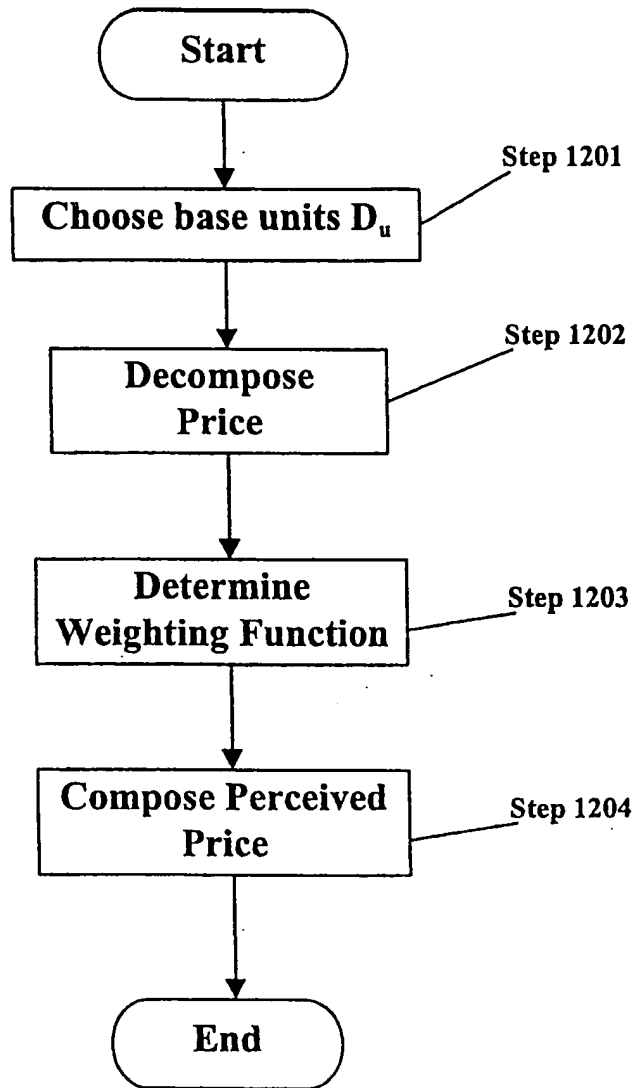
η = 0.04; D$_{MAX}$ = $1.00			$1.99	$2.00	$2.19	$2.20	$2.49
u	D$_u$	Γ$_u$	N$_u$	N$_u$	N$_u$	N$_u$	N$_u$
1	$0.01	0.816	9		9		9
2	$0.10	0.908	4		1	2	4
3	$0.50	0.972	1				
4	$1.00	1.000	1	2	2	2	2
		ρ	1.9226	2.000	2.1642	2.1816	2.4366

Figure 6

P = $2.20	
	$\rho = \sum_u N_u D_u \Gamma_u$
	$\rho = 2 \times \$0.10 \times 0.908 + 2 \times \$1.00 \times 1.000$
	$\rho = 2.182$

Figure 7

```
                    ┌─────────────┐
                    │    Start    │
                    └─────────────┘
                           │
                           ▼
              ┌───────────────────────┐
              │   Select Base Prices  │────── Step 1301
              └───────────────────────┘
                           │
                           ▼
              ┌───────────────────────┐
              │   Select Weighting    │────── Step 1302
              │      Functions        │
              └───────────────────────┘
                           │
                           ▼
              ┌───────────────────────┐
              │  Compose Perceived    │────── Step 1303
              │        Price          │
              └───────────────────────┘
                           │
                           ▼
                    ┌─────────────┐
                    │     End     │
                    └─────────────┘
```
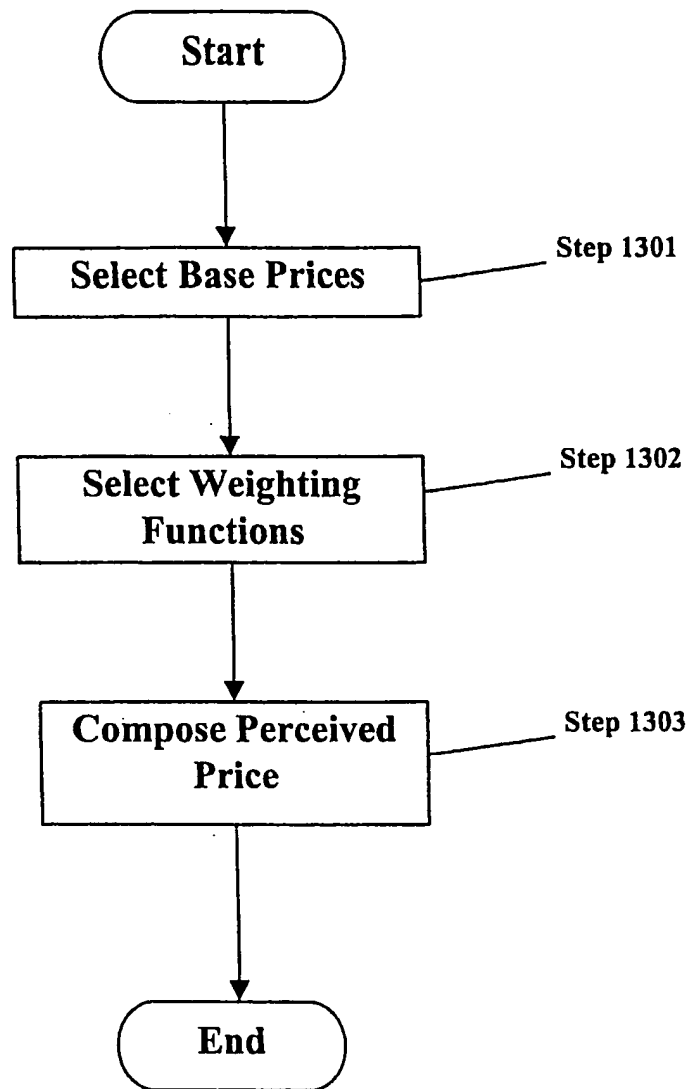
Figure 8

u	W_u	$1.99 P_u	$2.00 P_u	$2.19 P_u	$2.20 P_u	$2.49 P_u
1	5.9%	$1	$2	$2	$2	$2
2	42.4%	$1.9	$2.0	$2.1	$2.2	$2.4
3	51.7%	$1.99	$2.00	$2.19	$2.20	$2.49
	ρ	1.894	2.000	2.141	2.188	2.423

Figure 9

P = $1.99	
	$\rho = \sum_u P_u W_u$
	$\rho = (5.9\% \times \$1) + (42.4\% \times \$1.9) + (51.7\% \times \$1.99)$
	$\rho = 1.894$

Figure 10

Promotion	Visibility	Cost
Shelf sign	1.3	$1.50
Small Newspaper ad	1.8	$9.31
Large Newspaper ad	2.1	$37.60

Figure 11

Item	Price	Visibility
1	$1.49	1.3
2	$2.29	1.8
3	$4.69	2.1
4	$1.99	1.4
5	$2.49	2.2

Figure 12

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   G06F17/60

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6   G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 459 656 A (R.K. FIELDS ET AL) 17 October 1995 see column 1, line 40 – line 54 see column 3, line 54 – column 5, line 7; figure 2 —	1-21
A	US 5 377 095 A (M. MAEDA ET AL) 27 December 1994 see the whole document — -/--	1-21

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publicationdate of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of theinternational search	Date of mailing of the international search report
1 September 1998	08/09/1998

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	H. L. POH ET AL: "FORECASTING AND ANALYSIS OF MARKETING DATA USING NEURAL NETWORKS: A CASE OF ADVERTISING AND PROMOTION IMPACT" PROCEEDINGS OF THE 11TH CONFERENCE ON ARTIFICIAL INTELLIGENCE FOR APPLICATIONS, 20 - 23 February 1995, LOS ANGELES, CA, US, pages 224-230, XP000547057 see the whole document -----	1-21

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 5459656	A	17-10-1995	US	5712985 A	27-01-1998
			US	5299115 A	29-03-1994
US 5377095	A	27-12-1994	JP	5067119 A	19-03-1993